

NO LOOP.



US006151338A

**United States Patent** [19]  
**Grubb et al.**

[11] **Patent Number:** **6,151,338**  
 [45] **Date of Patent:** **Nov. 21, 2000**

[54] **HIGH POWER LASER OPTICAL AMPLIFIER SYSTEM**

[75] **Inventors:** Stephen G. Grubb, Fremont; David F. Welch, Menlo Park; Raymond Zanonl, Fremont, all of Calif.

[73] **Assignee:** SDL, Inc., San Jose, Calif.

[21] **Appl. No.:** 08/819,950

[22] **Filed:** Mar. 18, 1997

**Related U.S. Application Data**

[60] **Provisional application No.** 60/038,437, Feb. 19, 1997.

[51] **Int. Cl.<sup>7</sup>** ..... **H01S 3/30**

[52] **U.S. Cl.** ..... **372/6**

[58] **Field of Search** ..... 372/6; 359/177,  
 359/179, 341

[56] **References Cited**

**U.S. PATENT DOCUMENTS**

4,964,242	10/1990	Ruble et al.	51/144
5,062,021	10/1991	Ranjan et al.	360/135
5,088,240	2/1992	Ruble et al.	51/165
5,099,615	3/1992	Ruble et al.	51/165
5,136,600	8/1992	Fidric et al.	372/6
5,162,073	11/1992	Aronoff et al.	156/625
5,167,096	12/1992	Eltoukhy et al.	51/281
5,236,763	8/1993	Luthi	428/156
5,311,603	5/1994	Fidric	372/6
5,313,480	5/1994	Fidric et al.	372/6
5,385,092	1/1995	Lewis et al.	101/467
5,528,922	6/1996	Baumgart et al.	73/1 J
5,532,864	7/1996	Alexander et al.	372/6
5,533,040	7/1996	Zhang	372/25
5,541,947	7/1996	Mourou et al.	372/372
5,550,696	8/1996	Nguyen	360/135
5,567,484	10/1996	Baumgart et al.	427/555
5,576,918	11/1996	Bar-Gadla et al.	360/135
5,696,782	12/1997	Harter et al.	372/70

**FOREIGN PATENT DOCUMENTS**

0 685 946 A1	12/1995	European Pat. Off. .
0 729 207	8/1996	European Pat. Off. .
WO 86 02301	4/1986	WIPO .

**OTHER PUBLICATIONS**

D. Taverner et al., "158 mJ pulses from a single transverse mode large area erbium doped fiber amplifier", *Optics Letters*, vol. 22, No. 6, Mar. 15, 1997, Washington.

B. Desthieux et al., "111 KW (0.5mJ) pulse amplification at 1.4 mum using a gated cascade of three erbium doped fiber amplifiers" *Applied Physics Letters*, vol. 63, No. 5, Aug. 2, 1993, New York, US.

Minelly J.D. et al., "Femtosecond Pulse Amplification in Cladding-pumped Fibers" *Optics Letters*, vol. 20., No. 17, Sep. 1, 1995.

Galvanauskas et al., "High-power Amplification of Femto-second Optical Pulses in a Diode-pumped Fiber System" *Optics Letters*, vol. 19, No. 16, Aug. 15, 1994.

*Primary Examiner*—James W. Davie

*Assistant Examiner*—Robert E. Wise

*Attorney, Agent, or Firm*—W. Douglas Carothers, Jr.

[57] **ABSTRACT**

A high power laser optical amplifier system for material processing comprises multiple stage fiber amplifiers with rejection of propagating ASE buildup in and between the amplifier stages as well as elimination of SBS noise providing output powers in the range of about 10  $\mu$ J to about 100  $\mu$ J or more. The system is driven with a time varying drive signal from a modulated semiconductor laser signal source to produce an optical output allowing modification of the material while controlling its thermal sensitivity by varying pulse shapes or pulse widths supplied at a desire repetition rate via modulation of a semiconductor laser signal source to the system to precisely control the applied power application of the beam relative to the thermal sensitivity of the material to be processed. The high power fiber amplifier system has particular utility in high power applications requiring process treatment of surfaces, such as polymeric, organic, ceramic and metal surfaces, e.g., material processing, surface texturing, heat treatment, surface engraving, fine micro-machining, surface ablation, cutting, grooving, bump forming, coating, soldering, sealing, surface diffusion and surface conversion to a compound. A particular example is given for texturing of disk surfaces of magnetic disk media prior to the deposition or coating of a thin magnetic film on the textured surfaces to prevent slider stiction.

**29 Claims, 6 Drawing Sheets**

